

**Curriculum Vitae – Fred Russell Kramer****Personal**

Birth July 7, 1942 – New York City  
 Family Married – two children

**Education**

1956 - 1959 The Bronx High School of Science  
 1959 - 1964 University of Michigan – B.S. with Honors in Zoology  
 1964 - 1969 The Rockefeller University – Ph.D. (with Vincent Allfrey)  
 1969 - 1972 Columbia University – Postdoctoral training (with Sol Spiegelman)

**Experience**

1962 - 1964 Laboratory Technician, Cytogenetics Laboratory  
 Carnegie Institution of Washington, Ann Arbor, Michigan

1969 - 1986 Department of Genetics and Development  
 and Institute of Cancer Research  
 College of Physicians and Surgeons  
 Columbia University

1969 - 1971 Fellow of the American Cancer Society  
 1971 - 1972 Research Associate  
 1972 - 1973 Instructor  
 1973 - 1980 Assistant Professor  
 1980 - 1983 Senior Research Associate  
 1983 - 1986 Research Scientist

1986 - present Member and Chairman, Department of Molecular Genetics  
 The Public Health Research Institute

1987 - present Research Professor of Microbiology and Cell Biology  
 New York University School of Medicine

**Professional activities**

Member of the Corporation, Bermuda Biological Station  
 American Association of University Professors  
 New York Academy of Sciences  
 American Society for Biochemistry and Molecular Biology  
 American Society of Microbiology  
 The RNA Society  
 Society of the Sigma Xi  
 President, Kramer Consulting, Inc.

## Bibliography

### Structure and function of lampbrush chromosomes

1. Kramer FR (1964) The kinetics of deoxyribonuclease action on the lampbrush chromosomes of *Triturus*. Undergraduate honors thesis. University of Michigan. Thesis advisors: Berwind P. Kaufmann and Helen Gay.
2. Davidson EH, Crippa M, Kramer FR, and Mirsky AE (1966) Genomic function during the lampbrush chromosome stage of amphibian oogenesis. *Proc Natl Acad Sci USA* 56, 856-863.

### Translation of messenger RNA

3. Kramer FR (1969) Factors affecting translation of messenger RNAs *in vitro*: use of a GTP analog to investigate rates of polypeptide chain elongation. Doctoral dissertation. The Rockefeller University. Thesis advisor: Vincent Allfrey.

### Sequence and structure of replicating RNAs

4. Kacian DL, Mills DR, Kramer FR, and Spiegelman S (1972) A replicating RNA molecule suitable for a detailed analysis of extracellular evolution and replication. *Proc Natl Acad Sci USA* 69, 3039-3042.
5. Mills DR, Kramer FR, and Spiegelman S (1973) Complete nucleotide sequence of a replicating RNA molecule. *Science* 180, 916-927.
6. Mills DR, Kramer FR, Dobkin C, Nishihara T, and Spiegelman S (1975) Nucleotide sequence of microvariant RNA: another small replicating molecule. *Proc Natl Acad Sci USA* 72, 4252-4256.
7. Klotz G, Kramer FR, and Kleinschmidt AK (1980) Conformational details of partially base-paired small RNAs in the nanometer range. *Electron Microscopy* 2, 530-531.

### *In vitro* evolution of replicating RNAs

8. Kramer FR, Mills DR, Cole PE, Nishihara T, and Spiegelman S (1974) Evolution *in vitro*: sequence and phenotype of a mutant RNA resistant to ethidium bromide. *J Mol Biol* 89, 719-736.

### Sequence analysis by chain termination

9. Kramer FR and Mills DR (1978) RNA sequencing with radioactive chain-terminating ribonucleotides. *Proc Natl Acad Sci USA* 75, 5334-5338.
10. Mills DR and Kramer FR (1979) Structure-independent sequence analysis. *Proc Natl Acad Sci USA* 76, 2232-2235.
11. Axelrod VD and Kramer FR (1985) Transcription from bacteriophage T7 and SP6 RNA polymerase promoters in the presence of 3'-deoxyribonucleoside 5'-triphosphate chain terminators. *Biochemistry* 24, 5716-5723.

### Mechanism of RNA replication

12. Mills DR, Dobkin C, and Kramer FR (1978) Template-determined, variable rate of RNA chain elongation. *Cell* 15, 541-550.
13. Dobkin C, Mills DR, Kramer FR, and Spiegelman S (1979) RNA replication: required intermediates and the dissociation of template, product, and Q $\beta$  replicase. *Biochemistry* 18, 2038-2044.
14. Mills DR, Kramer FR, Dobkin C, Nishihara T, and Cole PE (1980) Modification of cytidines in a Q $\beta$  replicase template: analysis of conformation and localization of lethal nucleotide substitutions. *Biochemistry* 19, 228-236.
15. Kramer FR and Mills DR (1981) Secondary structure formation during RNA synthesis. *Nucleic Acids Res* 9, 5109-5124.
16. Bausch JN, Kramer FR, Miele EA, Dobkin C, and Mills DR (1983) Terminal adenylation in the synthesis of RNA by Q $\beta$  replicase. *J Biol Chem* 258, 1978-1984.
17. Nishihara T, Mills DR, and Kramer FR (1983) Localization of the Q $\beta$  replicase recognition site in MDV-1 RNA. *J Biochem* 93, 669-674.
18. LaFlamme SE, Kramer FR, and Mills DR (1986) Comparison of pausing during transcription and replication. *Nucleic Acids Res* 13, 8425-8440.
19. Priano C, Kramer FR, and Mills DR (1987) Evolution of RNA coliphages: the role of secondary structures during RNA replication. *Cold Spring Harbor Symp Quant Biol* 52, 321-330.

### **Replicable recombinant RNA**

20. Miele EA, Mills DR, and Kramer FR (1983) Autocatalytic replication of a recombinant RNA. *J Mol Biol* 171, 281-295.
21. Kramer FR, Miele EA, and Mills DR (1984) Recombinant RNA. In "The World Biotech Report 1984," Online Publications, Pinnar, United Kingdom, 347-356.

### **Gene detection utilizing recombinant RNAs**

22. Chu BC, Kramer FR, and Orgel LE (1986) Synthesis of an amplifiable reporter RNA for bioassays. *Nucleic Acids Res* 14, 5591-5603.
23. Lizardi PM, Guerra CE, Lomeli H, Tussie-Luna I, and Kramer FR (1988) Exponential amplification of recombinant RNA hybridization probes. *Biotechnology* 6, 1197-1202.
24. Lomeli H, Tyagi S, Pritchard CG, Lizardi PM, and Kramer FR (1989) Quantitative assays based on the use of replicatable hybridization probes. *Clin Chem* 35, 1826-1831.
25. Kramer FR and Lizardi PM (1989) Replicable RNA reporters. *Nature* 339, 401-402.
26. Kramer FR, Lizardi PM, and Tyagi S (1992) Q $\beta$  amplification assays. *Clin Chem* 38, 456-457.
27. Blok HJ and Kramer FR (1997) Amplifiable hybridization probes containing a molecular switch. *Mol Cell Probes* 11, 187-194.

### **Coupled replication-translation**

28. Wu Y, Zhang DY, and Kramer FR (1992) Amplifiable messenger RNA. *Proc Natl Acad Sci USA* 89, 11769-11773.
29. Ryabova L, Volianik E, Kurnasov O, Spirin A, Wu Y, and Kramer FR (1994) Coupled replication-translation of amplifiable messenger RNA: a cell-free protein synthesis system that mimics viral infection. *J Biol Chem* 269, 1501-1505.

### **Oligonucleotide arrays**

30. Chetverin AB and Kramer FR (1993) Sequencing pools of nucleic acids on oligonucleotide arrays. *Biosystems* 30, 215-231.
31. Chetverin AB and Kramer FR (1994) Oligonucleotide arrays: new concepts and possibilities. *Biotechnology* 12, 1093-1099.

**Binary hybridization probes**

32. Tyagi S, Landegren U, Tazi M, Lizardi PM, and Kramer FR (1996) Extremely sensitive, background-free gene detection using binary probes and Q $\beta$  replicase. *Proc Natl Acad Sci USA* 93, 5395-5400.
33. Hsuih TCH, Park YN, Zaretsky C, Wu F, Tyagi S, Kramer FR, Sperling R, and Zhang DY (1996) Novel, ligation-dependent PCR assay for detection of hepatitis C virus in serum. *J Clin Microbiol* 34, 501-507.

**Molecular beacons**

34. Tyagi S and Kramer FR (1996) Molecular beacons: probes that fluoresce upon hybridization. *Nature Biotechnol* 14, 303-308.
35. Tyagi S, Bratu DP, and Kramer FR (1998) Multicolor molecular beacons for allele discrimination. *Nature Biotechnol* 16, 49-53.
36. Kostrikis LG, Tyagi S, Mhlanga MM, Ho DD, and Kramer FR (1998) Spectral genotyping of human alleles. *Science* 279, 1228-1229.
37. Marras SAE, Kramer FR, and Tyagi S (1999) Multiplex detection of single-nucleotide variations using molecular beacons. *Genetic Analysis* 14, 151-156.
38. Bonnet G, Tyagi S, Libchaber A, and Kramer FR (1999) Thermodynamic basis of the enhanced specificity of structured DNA probes. *Proc Natl Acad Sci USA* 96, 6171-6176.
39. Vet JAM, Majithia AR, Marras SAE, Tyagi S, Dube S, Poiesz BJ, and Kramer FR (1999) Multiplex detection of four pathogenic retroviruses using molecular beacons. *Proc Natl Acad Sci USA* 96, 6394-6399.
40. Cayouette M, Sucharczuk A, Moores J, Tyagi S, and Kramer FR (1999) Using molecular beacons to monitor PCR product formation. *Strategies* 12, 85-92.
41. Tyagi S, Marras SAE, and Kramer FR (2000) Wavelength-shifting molecular beacons. *Nature Biotechnol* 18, 1191-1196.
42. Fung C, Tyagi S, Harris L, Weisberg S, Pinter A, and Kramer FR (2001) Genetic screening using molecular beacons. *Clin Chem* 47, in preparation.

### **Molecular beacon applications**

43. Gao W, Tyagi S, Kramer FR, and Goldman E (1997) Messenger RNA release from ribosomes during 5'-translational blockage by consecutive low-usage arginine but not leucine codons in *Escherichia coli*. *Mol Microbiol* 25, 707-716.
44. Leone G, van Schijndel H, van Gemen B, Kramer FR, and Schoen CD (1998) Molecular beacon probes combined with amplification by NASBA enable homogeneous, real-time detection of RNA. *Nucleic Acids Res* 26, 2150-2155.
45. Xiao G, Chicas A, Olivier M, Taya Y, Tyagi S, Kramer FR, and Bargonetti J (2000) A DNA damage signal is required for p53 to activate gadd45. *Cancer Res* 60, 1711-1719.
46. Dracheva S, Marras SAE, Elhakem SL, Kramer FR, Davis KL, and Haroutunian V (2001) NMDA receptor expression in DLPFC of schizophrenics. *Amer J Psychiat* 158, in press.

### ***Mycobacterium tuberculosis***

47. Piatek AS, Tyagi S, Pol AC, Telenti A, Miller LP, Kramer FR, and Alland D (1998) Molecular beacon sequence analysis for detecting drug resistance in *Mycobacterium tuberculosis*. *Nature Biotechnol* 16, 359-363.
48. Manganelli R, Dubnau E, Tyagi S, Kramer FR, and Smith I (1999) Differential expression of ten sigma factor genes in *Mycobacterium tuberculosis*. *Mol Microbiol* 31, 715-724.
49. Rhee JT, Piatek, AS, Small PM, Harris LM, Chaparro SV, Kramer FR, and Alland D (1999) Molecular epidemiologic evaluation of transmissibility and virulence of *Mycobacterium tuberculosis*. *J Clin Microbiol* 37, 1764-1770.
50. Piatek AS, Telenti A, Murray MR, El-Hajj H, Jacobs WR Jr, Kramer FR, and Alland D (2000) Genotypic analysis of *Mycobacterium tuberculosis* in two distinct populations using molecular beacons: implications for rapid susceptibility testing. *Antimicrob Agents Chemother* 44, 103-110.
51. El-Hajj H, Marras SAE, Tyagi S, Kramer FR, and Alland D (2001) Detection of rifampin resistance in *Mycobacterium tuberculosis* in a single tube with molecular beacons. *J Clin Microbiol* 39, in press.

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52. Spiegelman S, Mills DR, and Kramer FR (1976) The extracellular evolution of structure in replicating RNA molecules. In "Stability and Origin of Biological Information," Miller IR, ed, John Wiley & Sons, New York, 123-172.
53. Mills DR, Nishihara T, Dobkin C, Kramer FR, Cole PE, and Spiegelman S (1977) The role of template structure in the recognition mechanism of Q $\beta$  replicase. In "Nucleic Acid-Protein Recognition," Vogel HJ, ed, Academic Press, New York, 533-547.
54. Mills DR, Priano C, and Kramer FR (1987) Requirement for secondary structure formation during coliphage RNA replication. In "Positive Strand RNA Viruses," Brinton MA and Rueckert RR, eds, Alan R Liss, New York, 35-45.
55. Kramer FR and Lizardi PM (1990) Amplifiable hybridization probes. *Ann Biol Clin* 48, 409-411.
56. Lizardi PM and Kramer FR (1991) Exponential amplification of nucleic acids: new diagnostics using DNA polymerases and RNA replicases. *Trends Biotechnol* 9, 53-58.
57. Tyagi S, Marras SAE, Vet JAM, and Kramer FR (2000) Molecular beacons: hybridization probes for the detection of nucleic acids in homogeneous solutions. In "Nonradioactive Analysis of Biomolecules," Kessler C, ed, Springer-Verlag, Berlin, Germany , 606-616.
58. Marras SAE, Kramer FR, and Tyagi S (2001) Genotyping single nucleotide polymorphisms with molecular beacons. In "Single Nucleotide Polymorphisms: Methods and Protocols," Kwok PY, ed, Humana Press, Totowa, New Jersey, in press.

### Current Research Support

1. National Institutes of Health Grant RO1 HL-43521-10  
Molecular beacons for retroviral diagnostics  
June 1, 2000 to May 31, 2005  
Fred Russell Kramer, Principal Investigator  
\$562,448 this year (\$2,949,532 total award)
2. National Institutes of Health Grant RO1 ES-10536-02  
Detecting mRNAs in living cells with molecular beacons  
October 1, 1999 to September 30, 2002  
Sanjay Tyagi, Principal Investigator  
\$664,784 this year (\$1,594,450 total award)
3. Hamilton Thorne Research Grant  
Genetic screening with molecular beacons  
January 1, 2000 to December 31, 2001  
Fred Russell Kramer and Sanjay Tyagi, Co-Principal Investigators  
\$120,000 per year (\$240,000 total award)
4. Ortho-Clinical Diagnostics Research Grant  
Detection of rare *ras* mutations using allele-discriminating primers  
January 1, 2001 to October 31, 2002  
Fred Russell Kramer, Principal Investigator  
\$140,000 for 2001 (\$260,000 total award)
5. National Institutes of Health Grant RO1 HL-68513-01  
*Mycobacterium tuberculosis* and host gene expression during infection  
September 1, 2001 to August 31, 2006  
Issar Smith (Public Health Research Institute), Principal Investigator  
Sanjay Tyagi, Co-Investigator  
\$125,527 for the first year (\$622,630 total requested for our laboratory)
6. The Public Health Research Institute  
Laboratory share of royalties and fees received for licensed patents (ongoing income)  
Fred Russell Kramer and Sanjay Tyagi  
\$193,072 during 2000 (\$225,000 estimated for 2001)



## Patents and Patent Applications

### Gene detection utilizing recombinant RNAs

1. Kramer FR, Miele EA, and Mills DR. US Patents 4,786,600 (November 22, 1988), 5,620,870 (April 15, 1997), and 5,871,976 (February 16, 1999). Autocatalytic replication of recombinant RNA. Conceived at Columbia University. Licensed to Gene-Trak Systems.
2. Chu B, Kramer FR, Lizardi P, and Orgel LE. US Patents 4,957,858 (September 18, 1990) and 5,364,760 (November 15, 1994), and European Patent 0266399 (May 18, 1994). Replicative RNA reporter systems. Conceived at Columbia University and the Salk Institute for Biological Studies. Licensed to Gene-Trak Systems.
3. Kramer FR and Lizardi PM. US Patent 5,112,734 (May 12, 1992) and European Patent 0473693 (April 12, 1995). Target-dependent synthesis of an artificial gene for the synthesis of a replicative RNA. Conceived for Gene-Trak Systems.
4. Axelrod VD, Kramer FR, Lizardi PM, and Mills, DR. US Patents 5,356,774 (October 18, 1994) and 5,620,851 (April 15, 1997), and European Patent 0386228 (August 26, 1996). Replicative RNA-based amplification/detection systems. Conceived at Columbia University. Licensed to Gene-Trak Systems.
5. Kramer FR and Lizardi PM. European Patent 0346594 (May 31, 1995). Replicable hybridizable recombinant RNA probes and methods of using same. Conceived at Columbia University. Licensed to Gene-Trak Systems.
6. Kramer FR and Lizardi PM. US Patent 5,503,979 (April 2, 1996) and US Divisional Patent Application 08/484,992. Method of using replicatable hybridizable recombinant RNA probes. Conceived at Columbia University. Licensed to Gene-Trak Systems.

### Target-dependent molecular switches

7. Lizardi PM, Kramer FR, Tyagi S, Guerra CE, and Lomeli-Buyoli HM. US Patent 5,118,801 (June 2, 1992). Nucleic acid process containing an improved molecular switch. Conceived at PHRI. Licensed to 39 companies.
8. Lizardi PM, Kramer FR, Tyagi S, Guerra CE, Lomeli-Buyoli HM, Chu BC, Joyce GF, and Orgel LE. US Patent 5,312,728 (May 17, 1994) and European Patent 0436644 (April 17, 1996). Assays and kits incorporating nucleic acid probes containing an improved molecular switch. Conceived at PHRI and the Salk Institute for Biological Studies. Licensed to 39 companies.

**Coupled replication-translation**

9. Wu Y, Ryabova LA, Kurnasov OV, Morosov IY, Ugarov VI, Volianik EV, Chetverin AB, Zhang D, Kramer FR, and Spirin AS. US Patent 5,556,769 (September 17, 1996). Coupled replication-translation methods and kits for protein synthesis. Conceived at PHRI.
10. Kramer FR, Miele EA, and Mills DR. US Patent 5,602,001 (February 11, 1997). Cell-free method for synthesizing a protein. Conceived at Columbia University.

**Selection of improved ribozymes *in vivo***

11. Kramer FR, Dubnau D, Drlica KA, and Pinter A. US Patent 5,616,459 (April 1, 1997) and European Patent 0600877 (January 26, 2000). Selection of ribozymes that efficiently cleave target RNA. Conceived at PHRI.

**Oligonucleotide arrays**

12. Chetverin AB and Kramer FR. US Patent 6,103,463 (August 15, 2000). Method of sorting a mixture of nucleic acid strands on a binary array. Conceived at PHRI. Licensed to Affymetrix.
13. Chetverin AB and Kramer FR. US Divisional Patent Applications 08/473,010 and 09/164,249 (both which have been allowed). Novel oligonucleotide arrays and their use for sorting, isolating, sequencing, and manipulating nucleic acids. Conceived at PHRI. Licensed to Affymetrix.

**Binary hybridization probes**

14. Lizardi PM, Tyagi S, Landegren UD, Kramer FR, and Szostak JW. US Patent 5,652,107 (July 29, 1997). Diagnostic assays and kits for RNA using RNA binary probes and a ribozyme ligase. Conceived at PHRI and the Massachusetts General Hospital.
15. Tyagi S, Kramer FR, Lizardi PM, Landegren UD, and Blok HJ. US Patent 5,759,773 (June 2, 1998). Sensitive nucleic acid sandwich hybridization assay. Conceived at PHRI. Licensed to Vysis.
16. Tyagi S. US Patent 5,807,674 (September 15, 1998). Diagnostic assays and kits for RNA using RNA binary probes and a protein that is an RNA-directed RNA ligase. Conceived at PHRI. Licensed to Vysis.

**Molecular beacons**

17. Tyagi S, Kramer FR, and Lizardi PM. US patents 5,925,517 (July 20, 1999) and 6,103,476 (August 15, 2000). Detectably labeled dual conformation oligonucleotide probes, assays and kits. Conceived at PHRI. Licensed to 38 companies.
18. Tyagi S, Kramer FR, and Lizardi PM. European Patent Application 95904104.7. Hybridization probes for nucleic acid detection, universal stems, methods and kits. Conceived at PHRI. Licensed to 38 companies.
19. Tyagi S and Kramer FR. US Patent 6,150,097 (November 21, 2000). Nucleic acid detection probes having non-FRET fluorescence quenching and kits and assays including such probes. Conceived at PHRI. Licensed to 38 companies.
20. Kramer FR, Tyagi S, Alland D, Vet J, and Piatek A. International Patent Application PCT/US98/19182. Non-competitive co-amplification methods. Conceived at PHRI. Licensed to 38 companies.
21. Tyagi S, Kramer FR, and Marras SAE. US Patent 6,037,130 (March 14, 2000). Wavelength-shifting probes and primers and their use in assays and kits. Conceived at PHRI. Licensed to 38 companies.
22. Tyagi S, Kramer FR, and Alland D. International Patent Application PCT/US00/28515. Assays for short sequence variants. Conceived at PHRI.
23. Tyagi S and Kramer FR. Application in preparation. Molecular beacon pairs that interact by FRET to lower fluorescence background in living cells. Conceived at PHRI.

**Allele-discriminating primers**

24. Tyagi S, Kramer FR, and Vartikian R. US Patent 6,277,607 (August 21, 2001). High specificity primers, amplification methods and kits. Conceived at PHRI. Licensed to Ortho-Clinical Diagnostics.

**Allele-discriminating antisense therapeutics**

25. Tyagi S and Kramer FR. International Patent Application PCT/US00/14133. High specificity hairpin antisense oligonucleotides. Conceived at PHRI.

**Oligonucleotide-facilitated coalescence of cells and liposomes**

26. Tyagi S, Kramer FR, and Alsmadi OA. US Provisional Patent Application 60/239,698. Oligonucleotide-facilitated coalescence. Conceived at PHRI.